Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE

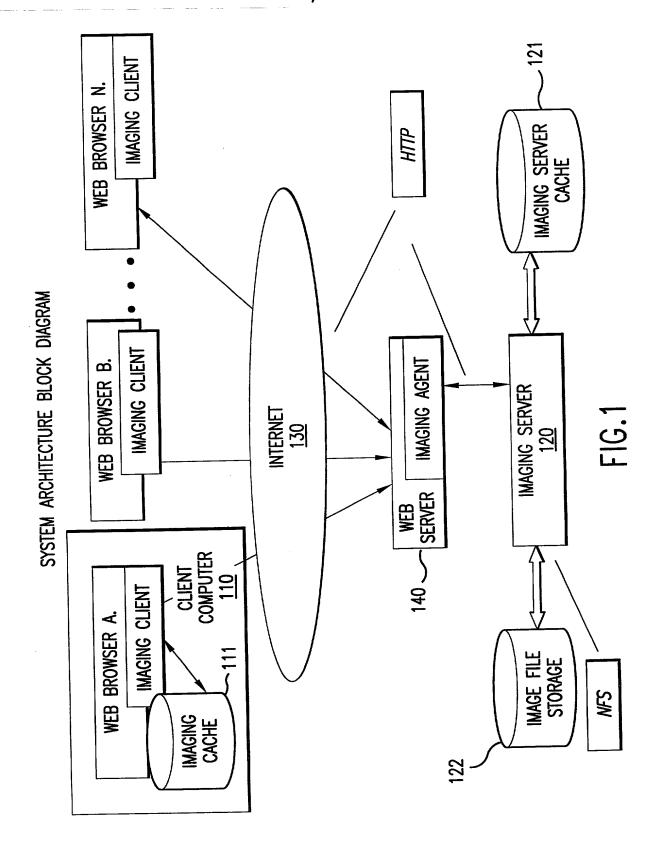
STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862 Docket No.: 18104.0011U1 Filing Date: April 17, 2001

Filing Date: April 17, 2001 Contact: Lawrence D. Maxwell, Esq. (404) 688-0770 EXPRESS MAIL LABEL NO.: EL491883026US

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Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

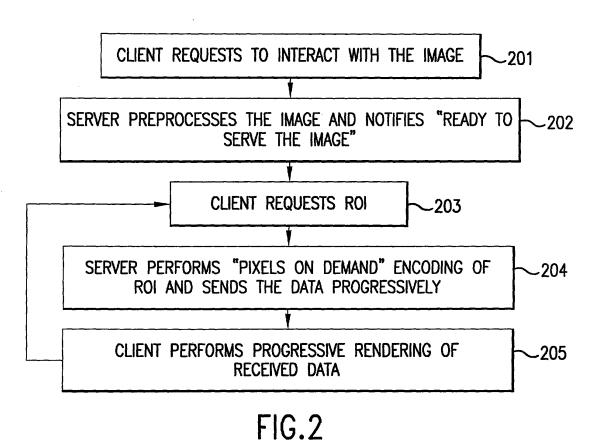
Serial No.: 09/837,862 Docket No.: 18104.0011U1 Filing Date: April 17, 2001

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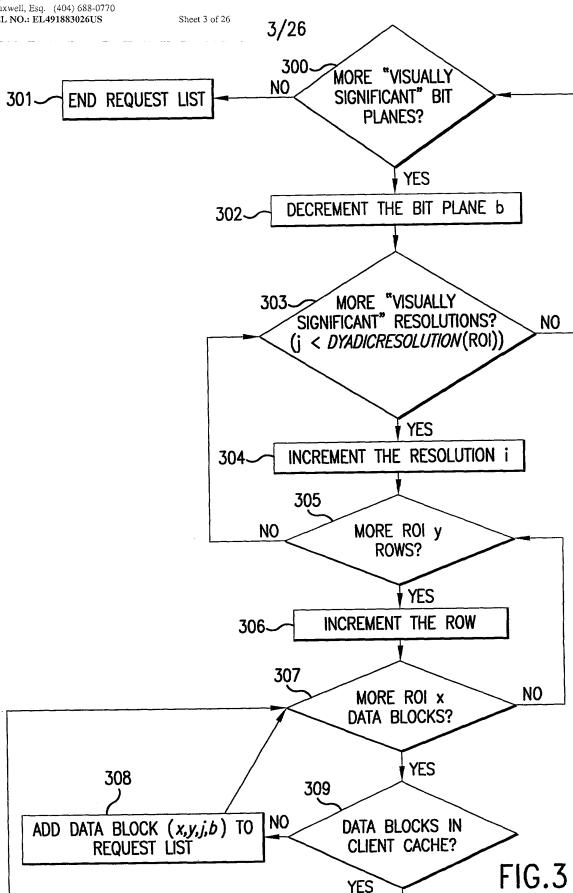
Inventors: Dekel et al. Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE

STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862 Docket No.: 18104.0011U1 Filing Date: April 17, 2001

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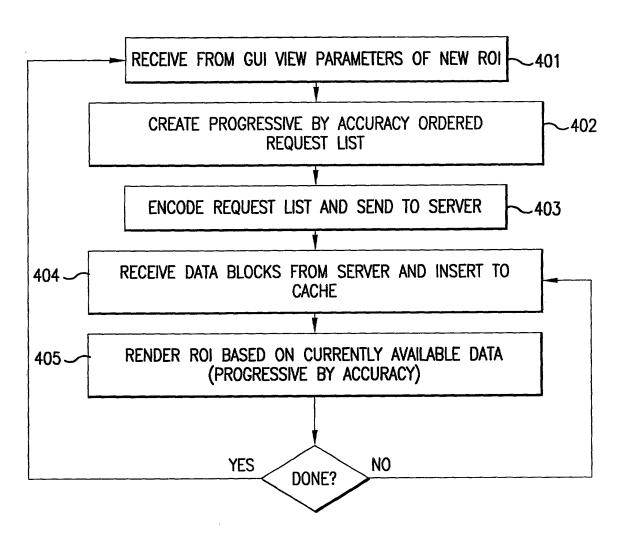


FIG.4

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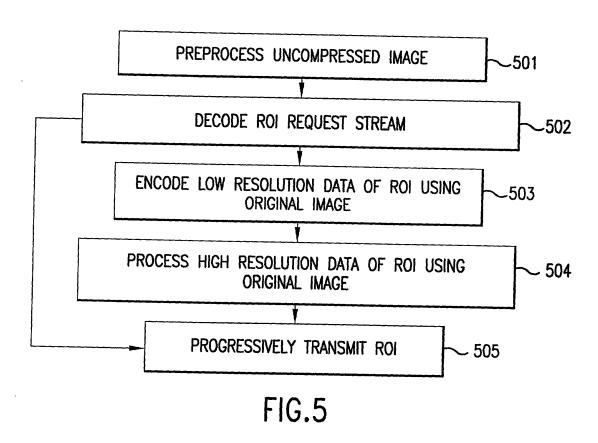
Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

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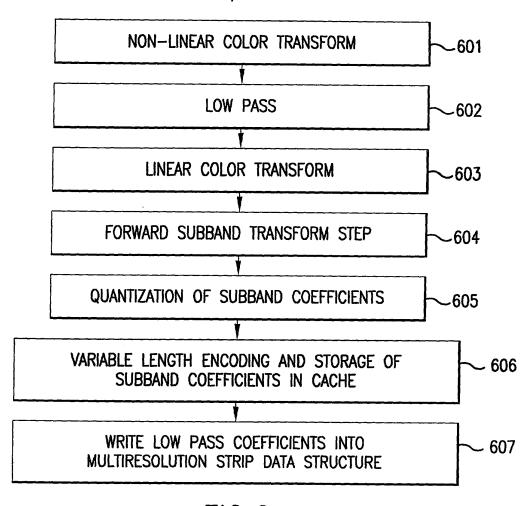


FIG.6

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

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VARIABLE LENGTH DECODING FROM CACHE OF SUBBAND TILE

ENCODE ROI DATA BLOCKS OF SUBBAND TILE

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FIG.7

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

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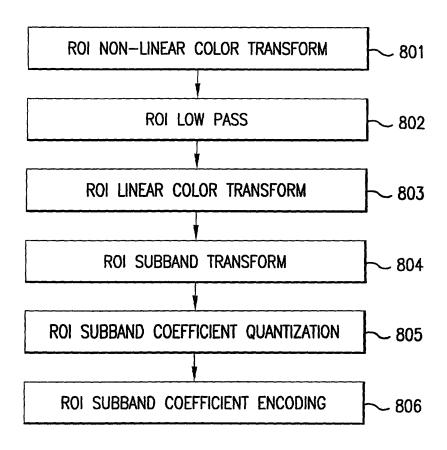


FIG.8

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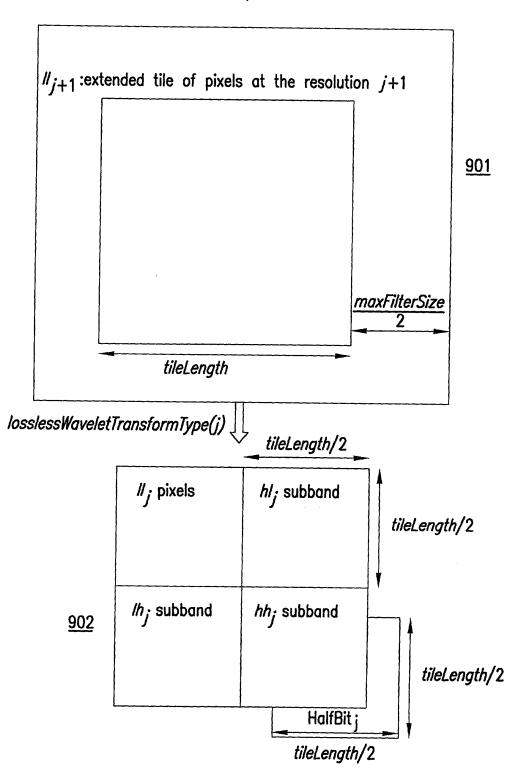


FIG.9

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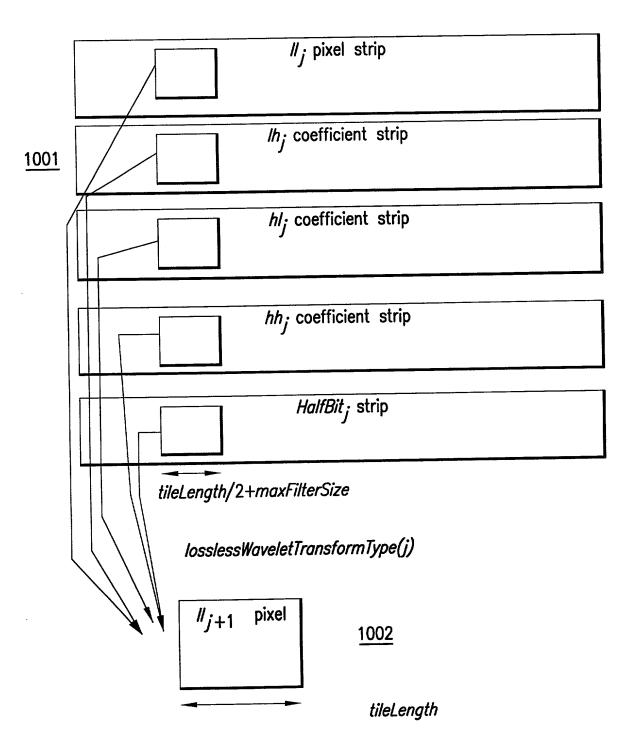


FIG.10

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

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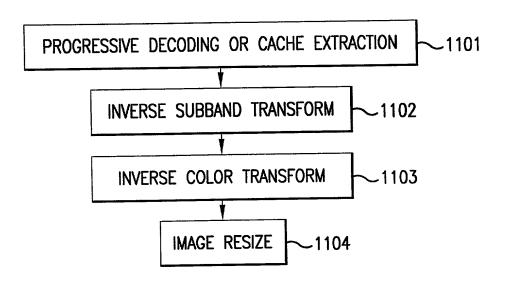


FIG.11

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

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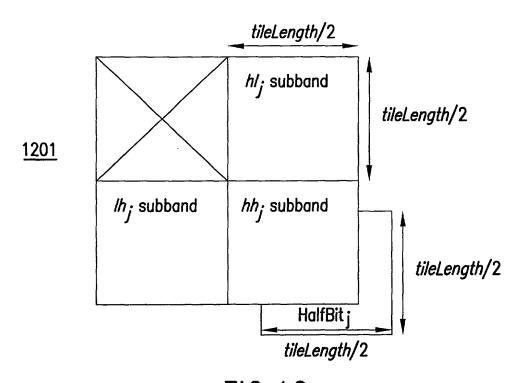


FIG.12

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

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RGB <-> YUV REVERSIBLE CONVERSION

FORWARD:

INVERSE:

$$Y_{r} = \left[\frac{R + 2G + B + 2}{4} \right]$$

$$U_{r} = R - G$$

$$V_{r} = B - G$$

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 $G = Y_{r} - \left[\frac{U_{r} + V_{r} + 2}{4} \right]$ $R = U_{r} + G$ $B = V_{r} + G$

FIG.13

Inventors: Dekel $\it et al.$ Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

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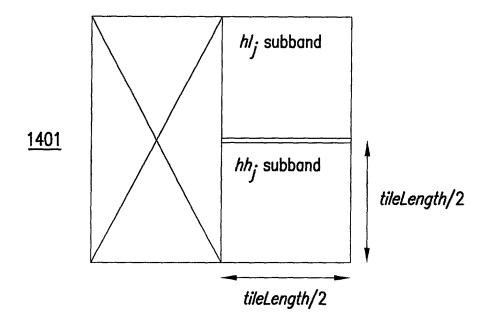


FIG.14

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```
bitModel.startModel () ;
zeroCoefModel.startModel () ;
coefSignModel.startModel () ;
while (encoder.moreCoef ()) {
   if (encoder.isCoefReported ()) {
   arithmetic_encode_symbol (bitModel,encoder.reportedCoefPrec isionBit ()) ;
   }
   else {
     if (encoder.isCoefExactZero ()) ;
     arithmetic_encode_symbol (zeroCoefModel,true) ;
     else {
        arithmetic_encode_symbol (zeroCoefModel,false) ;
        arithmetic_encode_symbol (coefSignModel,encoder.getCoefSign ()) ;
     }
   }
}
```

FIG.15a

```
bitModel.startModel ();
for (int i = 0; i < hBlockSize; i++) {
    for (int j = 0; j < hBlockSize; j++) {
        arithmetic_encode_symbol (bitModel,
    coefHalfBit [i] [j]);
    }
}</pre>
```

FIG.15b

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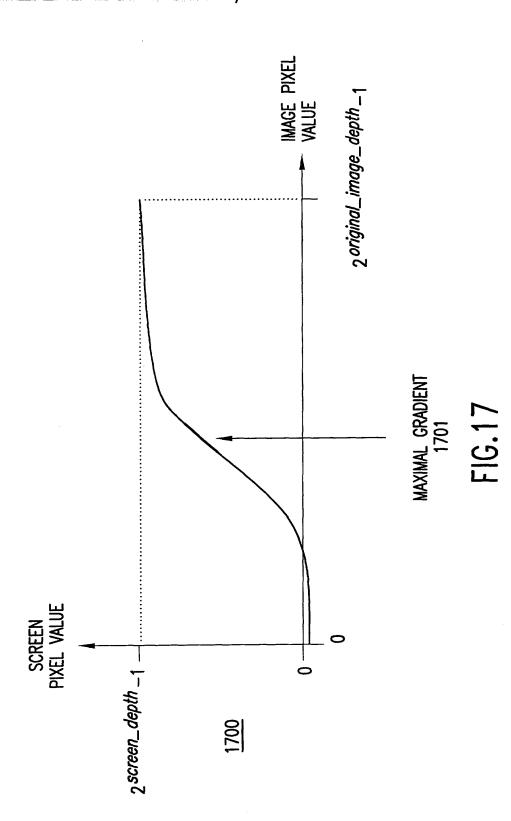
16/26 .startModel(); bitModel zeroCoefModel.startModel(); coefSignModel.startModel() ; decoder.initializeLSBPlaneCoefScan (); while (decoder.moreCoef ()) { if (decoder.isCoefReported ()) { if (decoder.isLHCoef ()) { decoder. updateLSB (0); else } decoder.updateLSB (arithmetic_decoder_symbol (bitModel)); else { if (!decoder.isLHCoef ()) { if (!arithmetic_decoder_symbol (zeroCoefModel)) decoder.setLSB (arithmetic_decoder_symbol (coefSignMode 1));

FIG.16a

```
bitModel.startModel ();
for (int i = 0; i < hBlockSize; i++) {
 for (int j = hBlockSize ; j ; j--,p++) {
  coefHlafBit [i] [j] = arithmetic_decoder_symbol (bitModel) ;
```

FIG.16b





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$$s = \left[s(1), s(2), \dots, s\left(\frac{N}{2}\right)\right]$$
 1D WAVELET TRANSFORM STEP
$$x = \left[x(1), x(2), \dots, x(N)\right] \Longrightarrow$$

$$d = \left[d(1), d(2), ..., d\left(\frac{N}{2}\right) \right]$$

$$X = \begin{bmatrix} x(1,1) & x(1,2) & \cdots & x(1,N) \\ x(2,1) & x(2,2) & \cdots & x(2,N) \\ \vdots & \vdots & \ddots & \vdots \\ x(M,1) & x(M,2) & \cdots & x(M,N) \end{bmatrix}$$

 $\hat{X} = \begin{bmatrix} \frac{LL}{LH} & \frac{HL}{HH} \end{bmatrix} = \begin{bmatrix} \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{1}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,N/2)} & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,N/2)} & \cdots & \frac{h}{(1,N/2)} \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} & \cdots \\ \frac{1}{(1,1)} & \cdots & \frac{h}{(1,1)} &$

FIG.18

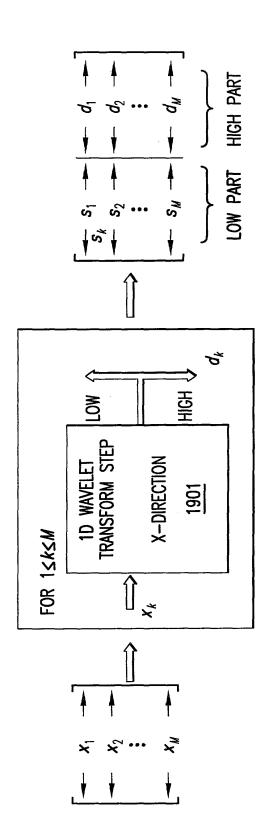
Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862 Docket No.: 18104.0011U1 Filing Date: April 17, 2001

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TEMPORAL MATRIX T=[S|D]

> 1901 FIG. 1

INPUT Matrix * Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

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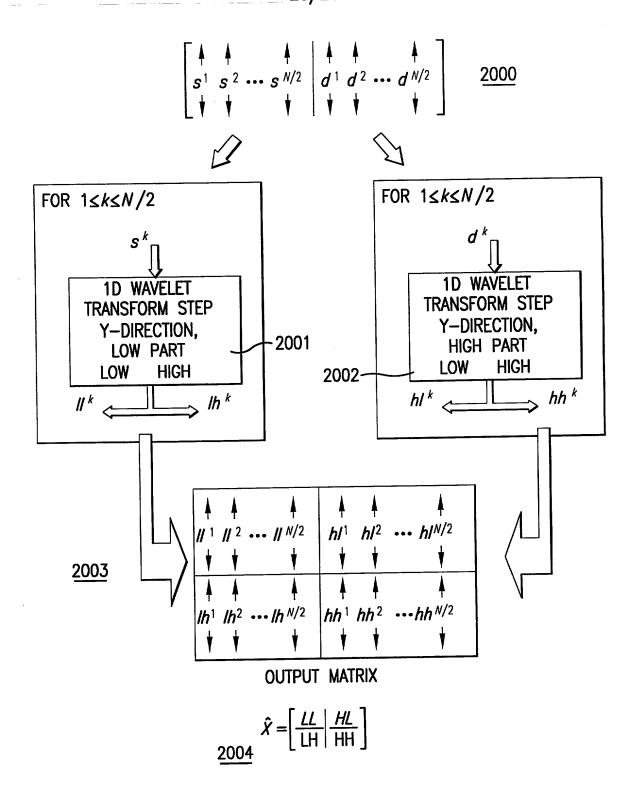


FIG.20

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

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LET I BE THE ORIGINAL IMAGE,

$$X_0 = I$$
 \longrightarrow $\begin{bmatrix} 2D \text{ WAVELET} \\ \text{TRANSFORM STEP} \end{bmatrix}$ \longrightarrow $\begin{bmatrix} \frac{LL_0}{LH_0} & \frac{HL_0}{HH_0} \end{bmatrix}$

FOR 0 < i < LEVELS

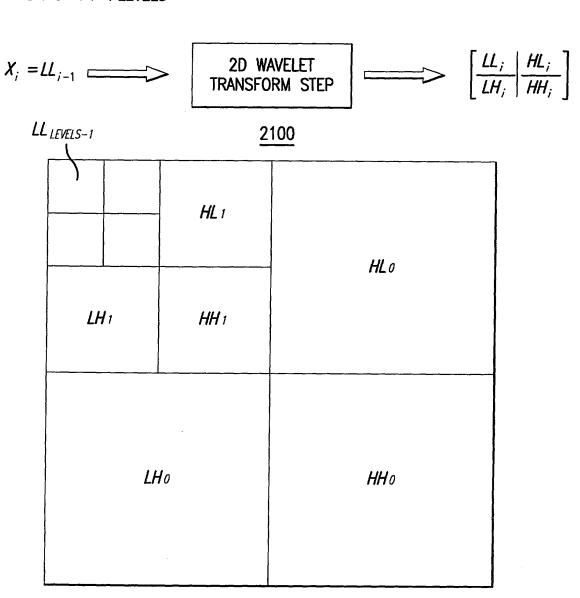


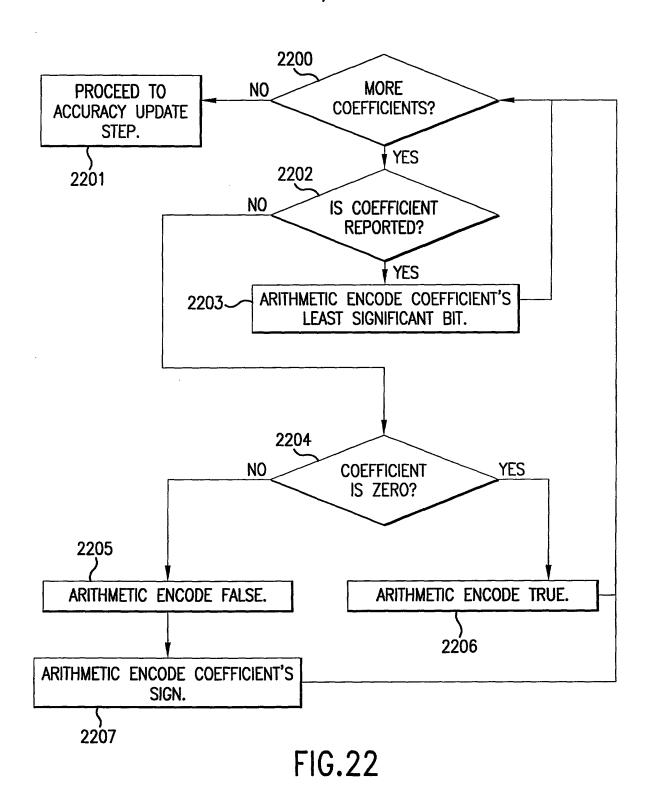
FIG.21

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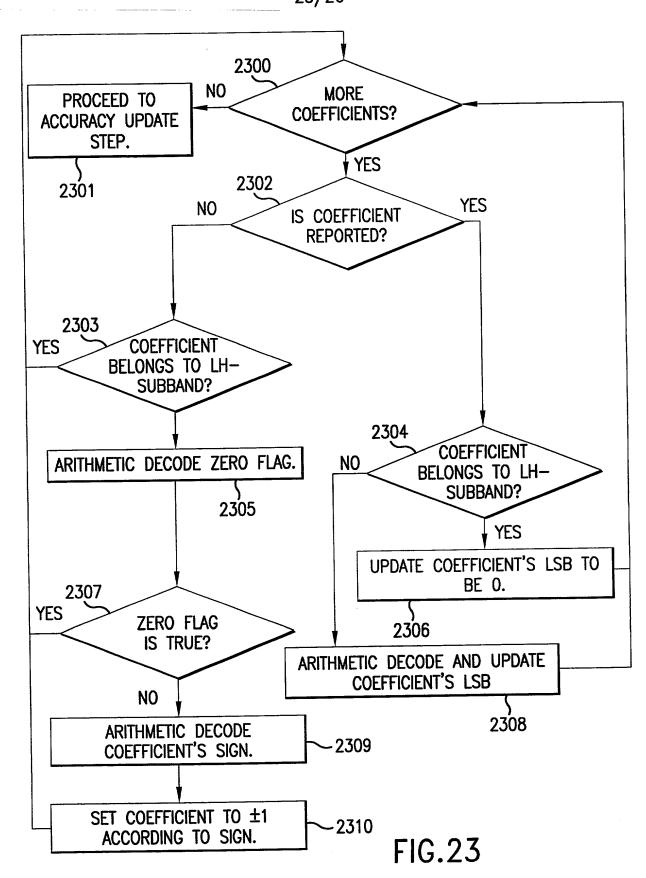
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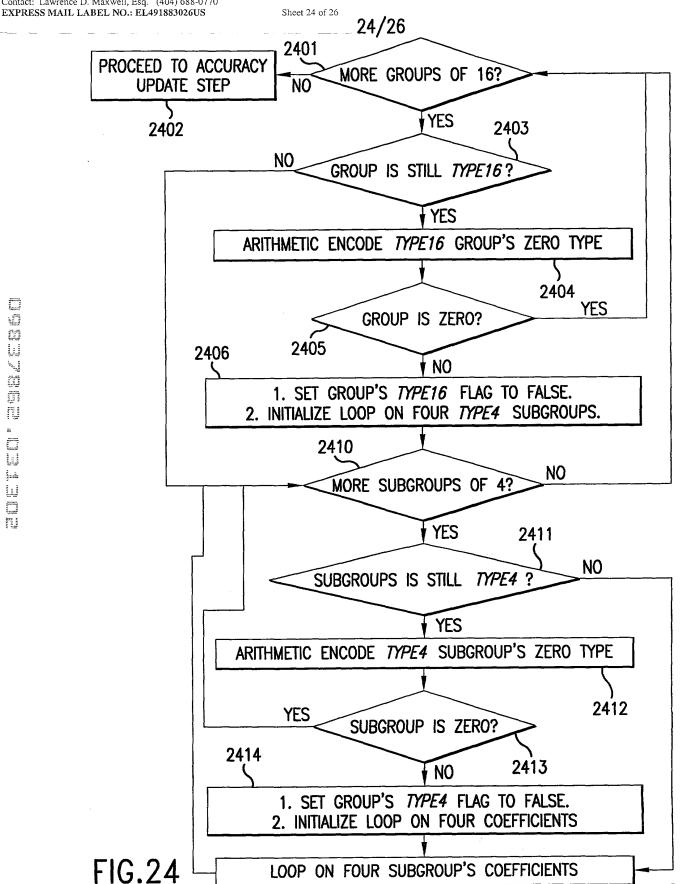


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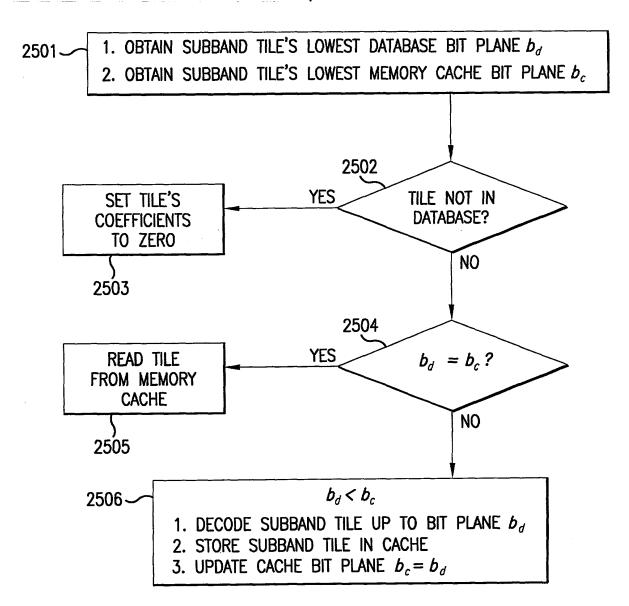


FIG.25

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

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PREPROCESSING MULTIRESOLUTION STRUCTURE

